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Vaginal axis on MRI after laparoscopic pectopexy surgery: a controlled study

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ABSTRACT

Aims: Laparoscopic pectopexy has emerged as a feasible alternative to sacrocolpopexy (SCP) for treating female genital apical prolapse. Although several previous studies have reported changes in the vaginal axis in women who have undergone SCP, laparoscopic lateral mesh suspension, sacrospinous ligament fixation surgery for prolapse, there is a lack of data on changes in the vaginal axis after pectopexy. This study aimed to evaluate the degree of anatomical correction achieved by laparoscopic pectopexy in patients with apical genital prolapse using magnetic resonance imaging (MRI).

Methods: Individuals who experienced pectopexy and a nulliparous control group were enrolled in this prospective observational case-control investigation. MRI scans were conducted on both the control cohort and the study group before and after the procedure. The angles formed by the pubococcygeal line and the inferior vaginal segment, the levator plate and the pubococcygeal line, as well as the inferior and superior vaginal segments, were measured and compared.

Results: The change in angle between the lower vagina and upper vagina was statistically significant, with preoperative and postoperative values of 134.91°±6.25° and 166.82°±6.15°, respectively (p=0.0001). The angle between the lower vagina and pubococcygeal line showed a significant change, with preoperative and postoperative values of 44.64°±1.8° and 65.73°±10.19°, respectively (p=0.0001). Postoperative angles were not similar among nulliparous patients based on the MRI findings. The postoperative Urogenital Distress Inventory scores are significantly lower than the preoperative scores (p=0.0001).

Conclusion: The pectopexy procedure is not optimal for achieving a normal vaginal axis.

Keywords: Apical prolapse, pelvic organ prolapse, pectopexy, laparoscopic lateral mesh suspension, sacrospinous ligament fixation (SSLF)

INTRODUCTION

Pelvic organ prolapse (POP) poses a significant health issue that impacts the overall physical and psychological well-being of women. The likelihood of requiring surgery for POP throughout a woman's lifetime stands at 12.6.[1] Prolapse of the anterior vaginal wall, or cystocele, is the most common form of POP, detected twice as often as posterior vaginal prolapse and three times more common than apical prolapse.[2] The primary objective of surgical treatment for POP is to relieve symptoms and restore the anatomical integrity of pelvic support. Typically, the vaginal axis lies in a relatively horizontal position to the levator plate, forming an angle of approximately 130° between the middle and lower vagina.[3] Sacrocolpopexy (SCP), considered the gold standard approach for treating POP, involves altering the typical anatomical position of the vaginal axis toward the sacral promontory. However, this adjustment can lead to increased abdominal pressure on the anterior wall, which causes symptoms of urgency or de novo anterior compartment prolapse. Although the long-term results of sacrospinous ligament fixation (SSLF), the primary vaginal surgery for correcting the apical anatomy in POP treatment, show promising outcomes,[4] it can increase the risk of anterior vaginal wall prolapse, similar to SCP, due to the deviation of the vaginal axis toward the posterior.[5]

The pectopexy procedure, initially described in 2007, utilizes iliopectineal ligaments on both sides for mesh attachment. In this procedure, the mesh is positioned along natural structures such as the round and broad ligaments, avoiding sensitive areas such as the ureter or bowel. A study has shown that the pectineal ligament (Cooper's ligament) exhibits stronger and more resilient tissue compared to the sacrospinous ligament and arcus tendineus of the fascia pelvis.[6] The iliopectineal ligament demonstrates strength and

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provides a secure hold for sutures. Additionally, the lateral portion of the iliopectineal ligament offers ample material for suturing, making pelvic floor reconstruction easier. This specific segment of the ligament is located at the level of the second sacral vertebra (S2), which coincides with the optimal position for the physiological axis of the vagina. The S2 level serves as the anchor point for maintaining the natural axis of the vagina.[7] Subsequent studies have demonstrated comparable outcomes in terms of supporting the apical compartment during intermediate follow-up periods when compared to laparoscopic SCP. However, this is only one study, and these are medium-term results.

The objective of this study was to assess the degree of anatomical correction achieved through laparoscopic pectopexy and to compare the vaginal axis of patients with apical genital prolapse to that of nulliparous women using magnetic resonance imaging (MRI). The secondary aim of the study was to evaluate sexual and urinary system functions following reconstructive POP surgery.

METHODS

The study was carried out with the permission of Ethical Committe of İstanbul Prof. Dr. Cemil Taşçıoğlu City Hospital (Date: 28.06.2022, Decision No: 351) and registered with the National Clinical Trials Registry under NCT05876975. Every participant granted their informed approval. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

A retrospective evaluation was conducted on patients who This observational prospective case-control study was conducted in a tertiary center between January and June 2023. The study group consisted of patients aged 18 and above diagnosed with apical POP and did not require an additional posterior colporrhaphy procedure. These patients had a specific preference for uterus-preserving surgery and were scheduled to undergo laparoscopic pectopexy. The assessment of POP was conducted using the POP-Q system. Exclusion criteria for the study included a uterine size exceeding 10 cm or the presence of a pelvic mass that could potentially interfere with accurate measurements. Patients with any congenital or acquired anatomical and reproductive anomalies, a diagnosed enterocele based on transperineal ultrasound before enrollment, an indication for hysterectomy, or the need for concomitant POP or anti-incontinence procedures were also excluded from the study. Patients who were scheduled to undergo laparoscopic pectopexy for apical prolapse were assigned to the study group. On the other hand, nulliparous women who visited the outpatient clinic with complaints unrelated to POP symptoms (e.g., menstrual irregularity) were randomly selected and assigned to the control group. The control group consisted of nulliparous individuals without POP symptoms, specifically those with asymptomatic grade 1 or lower POP, to minimize selection bias and enable comparison with a normal vaginal axis. Demographic information, including age, parity, and body mass index (BMI), was recorded for all participants. The pectopexy procedure was performed by a single surgeon. The primary goal of the study was to assess the change in the vaginal axis by comparing preoperative and postoperative MRI measurements of the patients, as well as comparing them to the nulliparous control group. MRI scans were performed on the axial, coronal, and sagittal planes, and diffusion-weighted images using a standard body spiral technique. The scans had a section thickness of 5 mm and were obtained with the subjects in a supine position. The secondary goal involved evaluating the improvement of urinary symptoms related to prolapse in the study group. Validated scales were applied for this purpose, including the Urinary Distress Inventory, Short Form (UDI-6), which is a shortened version of a condition-specific quality of life instrument. The UDI-6 is frequently used due to its feasibility and is validated at level a according to the international continence society grading system.[8] The UDI-6 scale includes six items that assess various aspects of urinary symptoms and their impact on daily life: 1) frequent urination, 2) leakage related to the feeling of urgency, 3) leakage related to activity, 4) coughing or sneezing causing small amounts of leakage (drops), 5) difficulty emptying the bladder, and 6) pain or discomfort in the lower abdominal or genital area. Higher scores on the UDI-6 indicate a higher level of disability in these areas. For the assessment of sexual function, the Female Sexual Function Index (FSFI) was utilized. The FSFI consists of six domains: desire, arousal, lubrication, orgasm, satisfaction, and pain. It comprises a total of 19 questions that relate to the participants' sexual life during the preceding 4 weeks. An overall FSFI score below 26.55 is indicative of female sexual dysfunction.[9] Scores higher than 26.55 indicate better sexual function.

Surgical Technique

There was no need for a special diet or bowel cleansing for the preoperative preparation of the patients. All patients were dressed with embolic compression stockings. Preoperatively 1.5 g Cefazolin was administered intravenously to the all patients for surgical prophylaxis. A 30-degree laparoscopic lens was guided into the abdomen with a 10-mm laparoscopic port from a 1 cm incision site on the lower edge of the umbilicus. Abdomen was inflated with carbon dioxide (CO_2) at 12 mm Hg pressure. Two 5-mm ports were placed to 2–4 cm inferomedial area of spina iliaca anterior superior bilaterally. One 15-mm port was placed on the left upper quadrant of abdomen. The round ligament part of 4 cm2 size which contains the lateral part of the ilopectineal ligament was used as the anatomical cue point. The peritoneum adjacent to the round ligament was superficially incised. The soft tissue in the pelvic wall was bluntly dissected until the iliopectineal ligament was seen, and the dissection was extended to the obturator nerve region. The same procedure was applied to the contralateral side. After the ilopectineal ligament was prepared, the peritoneal incision on the 2 sides was bluntly expanded along an imaginary line connecting the vaginal apex and pectineal line. Polypropylene monofilament mesh (3×15 cm) and 2-0 non-absorbable suture 10-mm sent from the port to the surgical area. The proximal end portions of mesh were fixed to the bilateral iliopectineal ligament with 2 sutures and the suture needle was taken out. Cervical bulge or vaginal apex were fixed to the middle of the mesh in the tension to prevent sagging. If the length of the mesh was long, the length of the

mesh was shortened before the second iliopectineal ligament was fixed. Laparoscopic tacker was used instead of suture while the mesh was fixed to the Karslı A.; Karslı O.; Kale A. 28) Prague Medical Report / Vol. 122 (2021) No. 1, p. 25–33 tissues in some patients (Jelovsek et al., 2007). The peritoneum was closed using 2-0 absorbable sutures. After the carbon dioxide was evacuated, the ports were removed.

Pelvic MRI Assessments

MRI images were acquired using a 1.5 Tesla MRI device (Solo, Siemens, Germany) with 16-channel phased array coils. The images were obtained while the patients were in supine position. The imaging protocol included T1A (TR/TE: 609/19 ms, slice thickness/gap: 5/1, matrix: 256 × 128, field of view: 30 cm, 1 excitation) and T2A axial STIR (TR/TE: 4000/46 ms, slice thickness/gap: 5/1, matrix: 256 × 256, field of view: 18-20 cm), as well as T2A axial (TR/TE: 7220/103) images. During the examination, no rectal or vaginal contrast material was used. However, defecation and urination were recommended before the MRI so that the bladder and rectum were not full. Subsequently, the imaging was performed with the bladder and rectum in their spontaneous state. Angle measurements were made based on the axial images passing through the midline of the sagittal plane. The evaluation included measurements of the symphysis pubis, vaginal axis, coccygeal bone structures, and levator plate planes. The line drawn from the lower contour of the symphysis pubis to the lower anterior edge of the second coccygeal bone formed the main reference line (also known as sacrococcygeal inferior pubis point line). The anterior vaginal wall between the introitus and the cervix was divided into two regions: the lower region, which refers to the distal half of the anterior vaginal wall, and the middle region, which refers to the proximal half of the anterior vaginal wall. The upper vaginal region was defined as the portion connecting the anterior and posterior fornixes, specifically the cervical portion. The line drawn from the symphysis pubis to the lower edge of the second coccygeal bone was considered the pubococcygeal line. The line parallel to the levator ani muscle from its origin to the posterior bend of the rectum was considered the levator plate. The patients were recalled for control examination at the 6th postoperative month for repeat MRI examination, and UDI-6 and FSFI forms were filled out once more. Reference points are illustrated in Figure 1.

To assess the change in the vaginal axis, a stable reference line was required. The pubococcygeal line was chosen as the reference point for this purpose. The position of the lower vaginal segment was evaluated by comparing it to both the pubococcygeal line and the upper segment. The levator plate's level may provide information about the relieved pressure following the operation. A longitudinal axis was drawn through the middle of the levator plate and the pubococcygeal line, extending between the inferior aspect of the symphysis pubis and the coccyx. This allowed for the measurement of angles to determine the change in the vaginal axis. Specifically, the angles measured were angle A (between the levator plate and the pubococcygeal line), angle B (between the lower and upper vaginal segments), and angle C (between the pubococcygeal line and the lower vaginal segment). These measurements were performed by a single specialized radiologist who was blinded to both the participants and the study hypothesis. The angles are depicted in Figure 2.

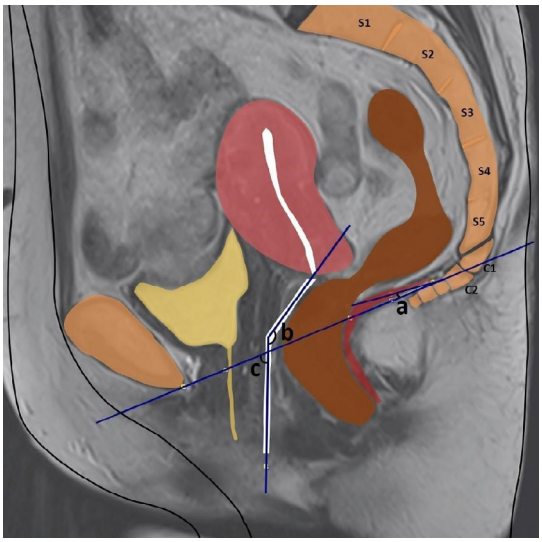
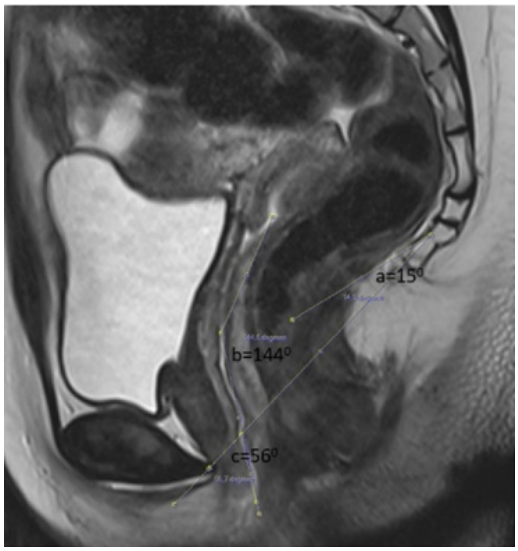


Figure 1. Reference points used in the study



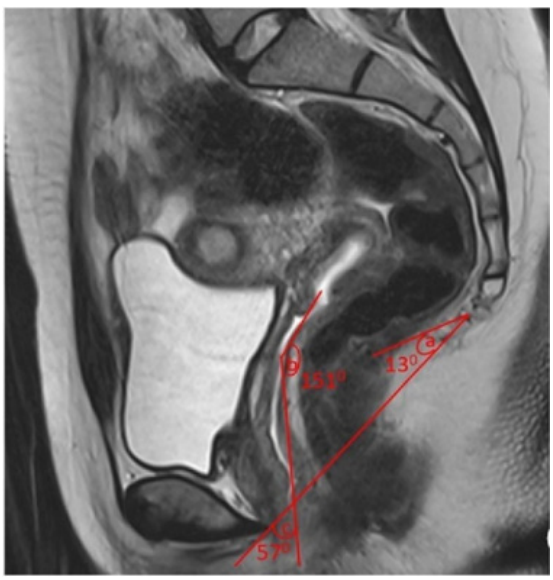


Figure 2. Preoperative-postoperative MR, angles: A, B and C angle

Statistical Analysis

In this study, statistical analyses were conducted using the NCSS (Number Cruncher Statistical System) 2007 Statistical Software package program (Utah, USA).In the evaluation of the data, descriptive statistical methods such as mean and standard deviation were used, along with the Shapiro-Wilk normality test to examine the distribution of variables. A paired t-test was used for the comparison of preoperative and postoperative variables that exhibited a normal distribution, and an independent t-test was used for the comparison of paired groups. The reliability of the used UDI and FSFI scales was determined through the Cronbach alpha test. The outcomes were assessed at a significance threshold of $p<0.05$.

RESULTS

A total of 60 patients were included in the study, of which 30 underwent a laparoscopic pectopexy procedure. The other 30 patients comprised the control group, consisting of nulliparous women. The mean age of the operated group was 58.27±5.14, and the mean age of the nulliparous control group was 24.60±1.51 ($p<0.01$). The average BMI of the patients who underwent pectopexy was 26.64±1.91, whereas the control group had an average BMI of 24.00±1.49 ($p=0.002$). The median parity of the operated group was 3 (range 3-4). Demographic data are summarized in Table 1.

Table 1. Demographic data of the patients

	Control group n:30	Study group n:30	p*
Age (mean±SD)	24.60±1.51	58.27±5.14	**p< 0.01**
BMI (mean±SD)	24.00±1.49	26.64±1.91	**0.002**
Parity (median)		3 (3-4)	

BMI: Body mass index, SD: Standart deviation

There was a significant change in the POP-Q grades for the anterior and apical compartments ($p=0.0001$). In the group that underwent pectopexy, the POP-Q measurements showed significant improvement. The differences at postoperative points Ba, Bp, and C were 4.12±0.15, 3.38±0.18, and 8.40±0.38, respectively ($p=0.0001$). The angle between the preoperative and postoperative levator plate and pubococcygeal line (angle A) was 7.64°±0.92° and 11.00°±3.00°, respectively ($p=0.005$). The change in angle between the lower vagina and upper vagina (angle B) was statistically significant, with preoperative and postoperative values of 134.91°±6.25° and 166.82°±6.15°, respectively ($p=0.0001$). The angle between the lower vagina and pubococcygeal line (angle C) showed a significant change, with preoperative and postoperative values of 44.64°±1.8° and 65.73°±10.19°, respectively ($p=0.0001$). The findings are summarized in Table 2.

The angle between the levator plate and the pubococcygeal line (angle A) measured preoperatively for the study group and the control group was 7.64°±0.92° and 12.50°±3.1°, respectively ($p=0.0001$). The angle between the lower vagina and upper vagina (angle B) was significantly different between the preoperative study group (134.91°±6.25°) and the control group (150.3°±4.47°) ($p=0.0001$). The angle between the pubococcygeal line and the lower vagina (angle C) showed a statistically significant difference between the preoperative study group (44.64°±1.80°) and the control group (55.9°±5.04°) ($p=0.0001$). The angle between the levator plate and the pubococcygeal line (angle A) measured postoperatively for the study group and the control group was 11.00°±3.00° and 12.50°±3.1°, respectively ($p=0.274$). The angle between the lower vagina and upper vagina (angle B) was statistically significant for the study group and the control group, at 166.82°±6.15° and 150.3°±4.47°, respectively ($p=0.0001$). The angle between the pubococcygeal line and the lower vagina (angle C) showed a statistically significant difference between the postoperative study group (65.73°±10.19°) and the control group (55.9°±5.04°) ($p=0.013$). The findings are summarized in Table 3.

Figure 3 illustrates angle B in the study group and control group. The UDI-6 and FSFI questionnaires, which assess quality of life, are presented in Table 4.

The postoperative UDI scores (2.09±0.7) were significantly lower than the preoperative scores (12.27±0.91) ($p=0.0001$). The postoperative FSFI scores were significantly higher than the preoperative FSFI scores ($p=0.0001$).

DISCUSSION

In our study, we observed that the vaginal axis in women with POP after laparoscopic pectopexy was abnormal compared to that of the nulliparous women in the control group. Uterus-sparing pectopexy corrected visible POP but did not restore

Table 2. Preoperative and postoperative findings in the pectopexy group

	Preoperative	Postoperative	Difference Mean±SD	p‡
Ba	1.65±0.18	-2.47±0.1	4.12±0.15	0.0001
Bp	0.69±1.74	-2.69±0.44	3.38±0.18	0.0001
C	3.59±0.28	-4.81±0.29	8.40±0.38	0.0001
Angle A	7.64±0.92	11.00±3.00	-3.36±3.08	0.005
Angle B	134.91±6.25	166.82±6.15	-31.91±8.54	0.0001
Angle C	44.64±1.8	65.73±10.19	-21.09±10.53	0.0001

Angle A: between the levator plate and the pubococcygeal line, Angle B: between lower and upper vaginal segments, Angle C: between the pubococcygeal line and lower vaginal segment.

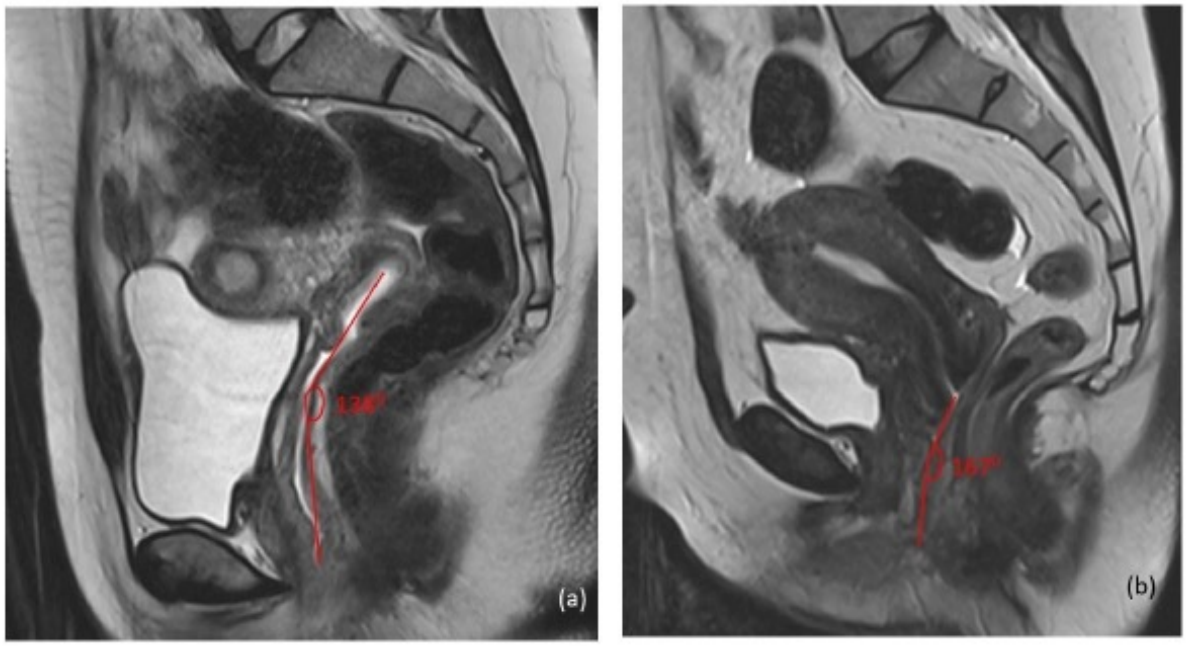


Figure 3. Reference points used in the study

Table 3. Comparison of angles on MRI scans

	Nulliparous n:30	Pectopexy n:30	p*
Preop Angle	12.50±3.1	7.64±0.92	0.0001
Postop Angle A		11.00±3.00	0.274
Preop Angle B	150.3±4.47	134.91±6.25	0.0001
Postop Angle B		166.82±6.15	0.0001
Preop Angle C	55.9±5.04	44.64±1.80	0.0001
Postop Angle C		65.73±10.19	0.013

Angle A: between the levator plate and the pubococcygeal line, Angle B: between lower and upper vaginal segments, Angle C: between the pubococcygeal line and lower vaginal segment.

the vaginal axis to its previous state. Surgical management of apical prolapse includes SSLF, laparoscopic lateral mesh suspension (LLMS), and SCP. As a secondary objective to reconstructive apical prolapse surgeries, restoring the vaginal axis to its normal limits is also crucial for the physiological functioning of the pelvis and abdomen.[10] Besides significant deterioration of the vaginal axis after SCP, it can also cause complaints such as pelvic pain and dyspareunia. In the SCP technique, the normal vaginal axis displaces posteriorly, causing de novo anterior prolapses by subjecting the anterior compartment to intra-abdominal pressure.[11] On the other hand, in recent years, the frequently performed LLMS has been shown to result in a vaginal axis close to normal after apical repair in MRI studies.[12] This has raised the question of whether LLMS surgery is the new gold standard in the treatment of apical prolapse in recent years.[13] In a different study, it was found that both SSLF and SCP resulted in deviation from the normal physiological axis in the vaginal axis assessment.[14]

In our MRI study, it was observed that the postoperative A, B, and C angles were not similar among nulliparous patients based on the MRI findings that we examined. This suggests that the pectopexy procedure may not be optimal for achieving a normal vaginal axis. The alignment of the vaginal axis has been recognized as a significant factor in pelvic organ support, and the restoration of vaginal depth and axis is regarded as a crucial objective in surgical management.[15] A study involving vaginograms on MRI after abdominal SCP and SSLF conducted on women in a supine position showed a 130° angle between the "upper and lower" vagina in a sample of 20 primarily nulliparous young women. In another study

Table 4.UDI-6, FSFI preoperative-postoperative

		Preoperative	Postoperative	Difference mean±SD	p‡
UDI Score		12.27±0.91	2.09±0.7	10.18±1.08	**0.0001**
FSFI	**Desire**	2.56±0.47	4.91±0.45	-2.35±0.63	**0.0001**
	Sexual arousal	2.35±0.4	3.41±0.83	-1.06±1.06	**0.008**
	Lubrication	2.18±0.49	3.79±0.65	-1.61±0.51	**0.0001**
	Orgasm	2.36±0.28	3.75±1.03	-1.38±1.03	**0.001**
	Satisfaction	2.36±0.61	3.27±0.87	-0.91±1.29	**0.042**
	Pain/discomfort	1.6±0.74	0.58±0.49	1.02±0.85	**0.003**
	Total score	13.42±0.82	19.71±2.67	-6.29±2.51	**0.0001**

‡Paired t test, UDI-6:Urinary Distress Inventory Short Form,FSFI:Female Sexual Function Index

conducted with a larger sample, the angle between the upper and middle vagina was found to be 149°.[16] These quantitative findings can be valuable in the context of suspension surgeries, as they provide insight into the normal axis and angles of the vaginal region. Having established normal values through imaging of postoperative patients, future assessments can be compared against these reference values. However, it is important to acknowledge the significant variation observed within the normal range and not overlook this aspect.

Pectopexy surgery offers some advantages over SCP in obese patients. In SCP, surgical dissection involves several important structures, including the right ureter, hypogastric nerves, middle sacral vessels, and sacral promontory, which contains the left common iliac vein. Obese patients pose a challenge in bowel handling and retroperitoneal dissection for anterior longitudinal ligament preparation due to the difficulties in identifying major landmarks.[17] Obesity increases surgical difficulty due to limited surgical space for balancing abdominal pressure and ensuring adequate ventilation.[18] Unlike SCP, pectopexy restricts surgical areas in the anterior pelvic space and is less affected by obesity. In the past, repair methods for prolapse that did not eliminate the pouch of Douglas (such as those involving anterior fixation points) were linked to higher rates of recurrence of posterior compartment prolapse or enterocele.[19] However, none of the patients in this series experienced a recurrence of posterior prolapse after surgery.

Improvements in urinary function were observed as one of the secondary objectives of our study following pectopexy. The incidence of new-onset urinary incontinence, especially stress urinary incontinence (SUI), is relatively high after pelvic floor surgery. In a study, a total of 220 women with symptomatic apical prolapse who underwent laparoscopic sacrocolpopexy were prospectively evaluated; 100 women had previously undergone a hysterectomy. The incidence of SUI following apical prolapse repair was found to be 23.6%. Subsequent continence procedures were performed in 5.0% of patients, all of whom were women with a previous hysterectomy, resulting in an 11% risk in this group.[20] In our study there was no significant difference in stress incontinence scores before and after the operation, suggesting that this aspect could be a potential area of future research, particularly in relation to the emergence of de novo stress urinary incontinence following SCP Although urinary incontinence problems are more associated with ligament defects rather than the shifting of the vaginal axis, they are closely connected to defects in the anterior wall due to the distinct alignment of the upper and lower vagina. The position of the lower vagina plays a significant role in the restoration of the lower urinary tract and is less influenced by the upper vagina.[21]

Sexual dysfunction is one of the symptoms associated with POP that motivates women to seek medical help. Women with POP are likely to restrict sexual activity owing to a perceived of loss of attractiveness and fear of incontinence. Conservative (pelvic floor muscles training or pessary) or surgical management (transabdominally or transvaginally) can be offered to treat POP but questions remain regarding sexual outcome.[22] In our study, significant improvements were observed in the FSFI after achieving anatomical success. While the improvements in secondary outcomes may be associated with better anatomical correction, it's important to emphasize that this conclusion cannot be solely inferred from our findings. Similar improvements would likely be observed with SCP or SSLF procedures as well.

Limitations

The primary limitation of the current study was the small sample size and short follow-up time. Reaching a definitive decision and judgment regarding the study is challenging. However, the use of MRI findings helped mitigate potential bias. To the best of our knowledge, this is the first study to evaluate the vaginal axis using MRI following laparoscopic pectopexy. Within our study group, we observed no new risks associated with the pectopexy technique. The placement of the mesh did not interfere with any pelvic structures, thereby reducing the risk of bowel infection or disorders to zero.

CONCLUSION

Additionally, there may be a protective effect on the anterior compartment. It is important to note that the pectopexy procedure should only be performed by experienced surgeons, as it adds to their technical repertoire. In cases where anatomic variations pose challenges, laparoscopic pectopexy can be considered as an alternative to sacral colpopexy. Conducting multicenter investigations would be beneficial in validating the clinical utility of laparoscopic pectopexy in routine practice.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ethical Committe of İstanbul Prof. Dr. Cemil Taşçıoğlu City Hospital (Date: 28.06.2022 Decision No: 351).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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